A SURVEY OF PUBLIC IMAGES OF MATHEMATICS LIM

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Abstract:
This paper reports initial findings of a survey that aims to explore the range of public images of mathematics. Over 500 adults aged 16+ *from all walks of life responded the short questionnaire given. Initial findings show that public images of mathematics and learning mathematics were given in the forms of propositions expressing opinions and views or in the form of metaphors. Five main categories of responses emerged from the analysis. They are (a) attitudes towards mathematics and its learning; (b) beliefs about respondents' own mathematical abilities; (c) descriptions of the process of learning mathematics; (d) epistemology and views of the nature (?f mathematics; and (e) values and goals in mathematics education. Some methodological issues and examples of each category are given and discussed in the paper.*

Introduction

Mathematics is a mysterious subject, and a number of myths are associated with mathematics. These myths include commonly expressed views including: "mathematics is just computation", "mathematics is only for clever people (and males)"; "your father is a maths teacher so you must be good in mathematics too". Such myths and images are widespread, are seem to be present in many countries, and among all classes of people. Moreover, most of these myths are negative [Buxton, 1981; Ernest, 1996; Peterson, 1996]. It is a matter of concern that these negative images of mathematics might be one of the factors that has led to the decrease in student enrolment in mathematics and science at institutions of higher education, in the past decade or two. However, there are relatively few systematic studies conducted on the subject of *myths* and *images of mathematics.* We need an answer to the questions: What are the of the general public's images and opinions of mathematics? We need to ascertain how popular or unpopular mathematics is, before we can design measures to improve or promote better public images. Therefore, this study aims to explore the range of images of mathematics held by a sample of the general public. It also aims to investigate the factors which might influence or cause these images. However, this paper only reports the initial findings of the first part of this survey, which was carried out during summer 1997 in the UK, as part of a Ph.D. research study.

The survey

This study employs an interpretative design because images are personal constructs that involve both the affective domain [feelings and attitudes], and the cognitive domain [knowledge and beliefs], including metaphors and related images. The meaning of image is taken as the 'mental representation or mental experience of something that is not immediately present to the senses, often involving memory' (McLeod, 1987, p.497). Thus the term 'image of mathematics' refers to a mental picture, view or attitude towards mathematics, presumably developed as a result of social experiences, through school, parents, peers, mass media or other influences.

The sample

The sample consisted of 548 adults of the general public aged 16+ who came from all walks of life.

To obtain a wide selection of the public, the location of data collection were public places such as a town high street, bus and train stations, an airport, and visitors to a cathedral, university campus and at a school open evening. We acknowledge that due to the constraints of time and resources, the sample is essentially an opportunity sample. (Although representatives for each empty or near empty sub-section of the sample stratified according to age band, gender, occupational grouping were actively sought, as far as possible: see Table 1). Only those who agreed to participate were sampled. The sample can be grouped into two main categories:

First there is the public who are directly involved in mathematics education such as mathematics teachers and mathematics students (this was a small part of the sample, 76 in total).

Second, there is the public who are not directly involved in mathematics education, including non-mathematics teachers and students.

This second category of the public was subdivided into five occupational grouping based on one of the common social survey classification, the Social Class based on Occupation (also called the Registrar General's Social Class) (The Office of Population Census and Survey, 1990). The detailed distribution of the sample is as shown in Table 1.

The sample was also classified (by self-report) into four age groups, namely, the youth group (age between 17-20); the young age group (age between 21-30); the middle age group (age between 3150); and the older age group (over 50 years old). The ages were grouped in such a way that the opinions of the sample might loosely reflect experiences of different stages in the evolution of the mathematics curriculum in England and Wales.

Table 1: The sample distribution according to age, occupation and gender

age group	maths teachers		maths students		teachers (non-maths)		students (non-maths)		profess-ional		Manag-erial & technical		skilled		unskill-ed		others		row total
Gender	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	M
17-20	0	0	12	11	0	0	29	27	0	0	0	0	4	6	4	4	1	2	100
21-30	5	1	13	8	7	0	33	22	4	14	15	13	10	14	7	2	1	2	171
31-50	10	11	0	3	14	7	2	3	9	25	29	13	18	15	21	12	0	7	199
Over 50	2	0	0	0	5	5	0	1	1	10	9	6	6	8	6	9	3	7	78
Total	17	12	25	22	26	12	64	53	14	49	53	32	38	43	38	27	5	18	548
Total F+M	29		47		38		117		63		85		81		65		23		548

Method

A short questionnaire using both open-ended and structured questions was designed to probe for the public's images of mathematics. It contains 10 questions which asked for respondents' liking or disliking of mathematics, their feelings when they thought of mathematics in school, their beliefs about mathematics learning, their views about mathematics education and their images of mathematicians. However, for this paper, only responses to two open-ended questions will be utilised. These asked the respondents to describe their images of mathematics and learning mathematics are discussed here. The responses were textual and were analysed qualitatively. The two open-ended questions are as given in Box 1 below:

Box 1: Open-ended question on images of mathematics and learning mathematics.

Q2 What kind of image do you have when you think of maths?
a) Maths is ______________________________
[Example: to some people, maths is ice cream, cold but tasty.]

b) Learning mathematics is like______________________________
[Example: to some people, learning mathematics is like watching a magic show-full of excitement and mysteries.]

Methodological issues/problems

Since the responses given were textual expressions, they were open to multiple interpretation. Some of the responses were given in the form of direct descriptions of attitudes such as 'mathematics is boring' or respondent's beliefs about their own mathematical abilities such as 'mathematics is misleading and confusing' [Respondent (R) 431]. However, many responses were also given in the form of a metaphor or simile such as 'mathematics is a nightmare' [RI8S] or 'maths is like Mt. Everest, difficult to climb but not impossible' [RS22]. This raises problems concerning the validity of our interpretation and data analysis.

To overcome this problem, a few measures have been taken to validate our interpretation. First, all ambiguous data was eliminated unless independent confirmation of the interpretation could be made. For example, one response to the question on the image of mathematics was 'maths is a snail shell in the garden' [RI17]. It was discarded because it opens up to too many possible interpretations and it was not possible to get further confirmation because the respondent did not agree to be interviewed in the second stage of this study. On the other hand, another response given was 'maths is pen and paper' [R239] which is equally ambiguous as the first one. However, it was possible to reconfirm and clarify its meaning with the respondent because she agreed to take up the follow-up interview in the second stage of the study.

Second, an attempt was made to classify the textual responses into as many categories as they can be represented in, because some responses contain composite views or mixed feelings. In order not to lose the richness of the data, each response was coded into one to three different categories or subcategories. For example, the response given: 'mathematics is a complicated but interesting subject' [R360] is coded into three subcategories: Code III : interesting; Code 411: a discipline or subject and Code 415: complexity.

In the whole process of categorisation and re-categorisation, we realised that it would be naIve for us to think that we could avoid personal bias and personal values during interpretations of data. To minimize this personal bias and prejudice, the data was also cross validated by systematic triangulation.

Firstly, the data was cross validated with four validators: two experts in mathematics education, one expert in quantitative research and one postgraduate research student. Their ages range from 29 years old to 60 years old. All of them have lived in Britain for more than 10 years, ensuring that they are familiar with the British culture, society and language. They were given the list of categories with verbatim examples taken from the data. We discussed and readjusted some of the categories according to our interpretations of the data. We then come to a compromise that resulted in a modified list of categorisation of the data. This process was repeated with each of the four validators.

Secondly, parts of the data together with the categories were validated by participants in a national mathematics education conference (BSRLM). The participants were given the list of categories and 20 sample responses in the form of metaphors or descriptions of the images of mathematics. After an explanation of the category chart (Figure 1, earlier version), the participants were divided into small discussion groups and given 15 minutes to categorise the 20 sample data according to their own interpretations. They were encouraged to create new categories if they felt the suggested list of categories was not adequate for the data given. After the group discussion, the category assigned by the researcher and the participants were compared. Only four items out of the 20 sample data were not matched. A few new categories such as 'impossible' emerged from the discussion and many more multiple categorisations were suggested for each item of data in the sample. Therefore the category chart was further modified and readjusted in the light of these suggestions. As a result of these two layers of validations, the final chart of categories for the images of mathematics of the sample was developed and is shown in Figure 1.

Findings and Discussion

Initial findings show that public images of mathematics and learning mathematics were given in the forms of propositions expressing opinions and views or in the form of metaphors and similes. Five main categories of responses emerged from the analysis. They are (a) attitudes towards mathematics and its learning; (b) beliefs about respondents' own mathematical abilities; (c) descriptions of the process of learning mathematics; (d) epistemology and views of the nature of mathematics; and (e) values and goals in mathematics education.

Category 1: Attitudes towards mathematics and its learning

Initial analysis shows that many respondents expressed their images of mathematics in the form of descriptions of attitudes, feelings or emotions that they had when they thought of mathematics or what the questions reminded them of Descriptive statements such as 'mathematics is difficult' [frequency(t)=68]; 'mathematics is boring' [f=59] or 'mathematics is interesting/rewarding' [f=62] are the three most common expressions. Metaphors which show positive images such as 'mathematics is like playing with my children, never tiresome' [R526] or negative images such as 'like eating nails -hard and painful' [RIll] are also commonly expressed.

As shown in Figure 1, over 44% of the entries indicate some kind of attitude, feeling or emotion. They range from positive attitudes such as 'mathematics is fun and exciting' [RI70] to negative attitudes such as 'mathematics is dull, boring complex' [RI82]. Others emphasise the importance of mathematics such as 'mathematics is important for everything' [RI75] while yet others see mathematics as 'irrelevant' [R053] and 'a lot of things which I will never use' [R059].

Category 2: *Beliefs about own mathematical ability*

Five percent of the responses reflected beliefs about the respondents' own mathematical abilities and experiences. Some believed that mathematics is difficult but possible to achieve success in, examples mathematics is 'like Mt. Everest, difficult to climb but not impossible' [R522]. Others hold the opposite view, example, 'mathematics is difficult and [I] find hard to cope with' [RO 11]. A number also found mathematics 'incomprehensible' [R027] or 'misleading and confusing' [R43I].

Category 3: *Descriptions of the process of learning mathematics*

Almost 14% described their images of mathematics in terms of the process of learning mathematics. Example, maths is, *'a skill* you need to learn' [R209]; *'problem solving,* explaining physical processes'[Rl13]; or a 'voyage of *discoveries'* [RlI6] and as *exploration,* for example, maths is 'like the arctic - unattractive but adventurous'[Rl08]. Many of the sample indicated that maths is a *hierarchical* process like 'a seven course meal, one theory leads to another' [R527] or involved *logical thinking* such as 'logical stimulation' [RIOO] or *mental work* such as maths is 'a subject to test the mind' [R468]. Mathematics is also viewed as process of *'hard work'* [R034], or *effortful endeavour* as 'something required concentration-satisfy when right' [R090]; a *repetitive process*, example, maths is *'repetitive*, structures and logical' [R105]. Among these eleven subcategories, logical thinking, mental work and problem solving were the three most common suggesting that for those who relate mathematics to learning, it is taken as a cognitive process of logical and analytical thought to solve problems.

Category 4: *Epistemology or the nature o.fmathematics*

Almost 30% of the responses corresponded to this category, making it the second most prominent category. For example, mathematics is identified with 'numbers and equations' [R005]; rules and procedures, pattern and structures. Mathematics is also viewed as a practical tool, a model, a language, a science or a discipline of study. The responses corresponding to this category are made up of a wide variety of constructs that related to epistemology, content and nature of mathematics.

Category 5: *Values and goals in mathematics education*

Over 8% of the responses referred to the goals and values of mathematics education. Eight subcategories emerged from the data. The most common category concerned the element of mystery in mathematics, example maths is 'like a woman - full of intriguing mysteries' [R167] or 'like swimming in the dark' [R442]. It is interesting to note that all responses in this subcategory were given as metaphors. The second most common category viewed mathematics as a challenging activity, example, maths is 'challenging' [R487] or 'a challenge' [R237], 'fun when everything works out but remains a challenge' [R470], or a 'challenging subject -- intellectually satisfying' [R120]. There were also responses that show the appreciation of the values in mathematics or the *beauty of mathematics*, example, 'mathematics is clean and reliable' [R061] or 'mathematics is like a sunset- unique and beautiful' [R168].

Conclusion

This initial analysis shows that the public's images of mathematics, at least in this sample, are closely related to their attitudes and feelings towards mathematics. The majority of them found mathematics difficult, boring or rewarding, and this was their most significant perception. Although many related their images of mathematics to the nature of mathematics, that is, to epistemology or content, by identifying maths with numbers and equations or rules and procedures, about 14% of them related maths to its process of learning. Less than 10% of responses related to values in mathematics education or reflected their beliefs about their own mathematics abilities. Further analysis in terms of gender, age groups and occupational grouping as well as the possible factors that might have influenced these people's images of mathematics are underway.

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Figure 1: Categories of image of mathematics and frequency[f] distribution of responses

Images of mathematics

Made up of attitudes, views, and metaphors categorised as follows;

Attitude (feelings) [f=350 or 43.7%]	Beliefs (about own mathematical ability) [f=40 or 5.0%]	Process of learning (teaching/learning) [f=110 or 13.7%]	Epistemology (nature of mathematics) [f=236 or 29.5%]	Values/goals (in mathematics education) [f=65 or 8.1%]
-111interesting [f=52] -112 rewarding [f=10] -121 boring [f=58] -122 enjoyable[f=38] -131 necessary [f=32] -133 important[f=8] -141 useful[f=21] -142 irrelevant [f=9] -151 difficult[f=68] -152 easy [f=10] -160 anxiety[f=44]	-201 difficult but possible[f=4] -202 difficult but rewarding[f=1] -203 incomprehensible[f=12 -204 inability[f=3] -205 confusion[f=20]	-301 problem solving[f=18] -302 skill[f=3] -303 hierarchical[f=3] -304 exploration[f=3] -305 discovery[f=3] -306 memorisation[f=0] -307 logical thinking[f=22] -308 repetitive process[f=8] -309 hard work[f=14] -310 effortful endeavour[f=11] -311 mental work[f=20] -312 getting difficult[f=4] -313 organising[f=1] -314 slow and pointless[f=0] -315 investigation[f=0] -316 getting easier[f=0]	-401 numbers and symbols[f=46] -402 rules and procedures[f=8] -403 patterns/structure[f=20] -404 equation/algebra[f=21] -405 a language[f=5] -406 practical tools[f=25] -407 exactness and precision[f=5] -408 formulae[f=4] -409 visual representations /geometry[f=12] -410 a science[f=10] -411 a discipline /subject[f=16] -412 proofs[f=1] -413 a model[f=7] -414 abstraction[f=5 -415 complexity[f=19] -416 calculation/manipulation of number [f=10] -417 games/puzzles[f=14] -418 theoretical[f=8]	-501 beauty of maths[f=20] -502 challenge[f=26] -503 mystery[f=4] -504 dangerous but attractive[f=1] -505 strange/foreign[f=3] -506 not creative/imaginative[f=2] -507 objective[f=6] -508orderly and tidiness[f=3]

f(frequency) = number of responses corresponding to the categories or subcategories.